REMARKS

I. INTRODUCTION

Favorable reconsideration of this application, in light of the present amendments and the following discussion, is respectfully requested.

II. STATUS OF THE CLAIMS

By the present amendment, claims 1-12 are canceled and new claims 13-21 are added. Claims 13 and 18 are independent. It is respectfully submitted that no new matter is added by this amendment. New independent claim 13 is similar to original claim 1; new dependent claims 14-17 are similar to original dependent claims 3, 4, 6, and 5, respectively. New independent claim 18 generally combines original claims 7 and 8. Dependent claims 19-21 are similar to original dependent claims 11, 12, and 10, respectfully.

III. SUMMARY OF THE OFFICE ACTION

In the November 15, 2007 Office Action, claims 1-12 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite; claims 1, 3-4, 7-8 and 10-12 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,543,411 to *Raab et al.* (hereinafter *Raab)*; and claims 2-3 and 9 are rejected under 35 U.S.C. § 103(a) as being obvious over *Raab*. Each rejection will be addressed with respect to new claims 13-21.

IV. THE REJECTIONS OF THE CLAIMS

A. <u>The Rejection of Claims 1-12 under 35 U.S.C. § 112, second paragraph</u>

Claims 1-12 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. In response, Applicants reviewed all of the claims for indefiniteness, grammatical and typographical errors. For clarity, Applicants have canceled claims 1-12 and added new claims 13-21, which eliminate any indefinite language and grammatical or typographical

errors. Accordingly, Applicants request withdrawal of the rejection under 35 U.S.C. § 112, second paragraph.

B. <u>The Rejection of Claims 1, 3-4, 7-8 and 10-12 under 35 U.S.C. § 102(b)</u>

Claims 1, 3, 4, 7, 8 and 10-12 are rejected under 35 U.S.C. §102(b) as being anticipated by *Raab*. *Raab* fails to anticipate new independent claims 13 and 18 because all of the limitations of those claims are not identically found in *Raab*.

<u>Raab</u>

Raab discloses two ways of fuel preparation for combustion in a conventional internal combustion four-stroke engine. According to the first way, a part of the exhaust gas is retained in the cylinder by early closing of the exhaust valve, the fuel is injected one stroke later (post closing) to be treated by hot exhaust gas and mixed with fresh air. A part of the fuel compounds with carbon monoxide from the exhaust gas to form carbon dioxide.

According to the second way of fuel preparation as described in *Raab*, the early closed exhaust valve also retains a part of exhaust gas in the cylinder, the intake valve is opened before the piston reaches the upper dead point, and a part of exhaust gas enters the intake tract into which the fuel is injected, mixing either with exhaust gas, compounding partially and forming carbon dioxide, or with fresh air.

When the exhaust valve is closed early during the piston movement to the upper dead point, the volume of the working space is reduced and both the pressure and the temperature increase. Therefore, the engine consumes considerably more work in that section of the piston path rather than during the usual exhaust stroke. When combusting a part of the injected fuel according to the second way, the pressure, the temperature and the lost work increase even more.

During the further piston movement from the upper dead point, the working space volume increases, which results in a decrease of the pressure and the temperature. To take in

fresh air, the piston has to move away from the upper dead point to the extent that pressure in the cylinder drops below the intake pressure (the pressure of the environment or pressure from the supercharger). That means a part of the piston travel for the fresh-air intake lowers considerably, reducing even more the proportional output of the engine where the second way is used. If the exhaust-gas temperature does not drop during the pressure drop below the temperature of the fuel ignition, which is typical in diesel engines, the remaining part of the fuel combusts at the moment when the mixture of exhaust gas and fuel vapor meets air, which interrupts the further intake of fresh air.

To reduce the drop, *Raab* proposes, according to the second way, to close the exhaust valve early, and simultaneously, open the intake valve before the pressure drops below the intake pressure, and release a part of hot exhaust gas to the intake tract. See claim 6 of *Raab*, for example. At the moment when the mixture of the exhaust gas and the fuel vapor meets air in the intake tract, carbon monoxide from the generated exhaust gas combusts in the intake tract. Although the fuel is treated by heat after injection for better combustion, the fuel simultaneously starts combusting. Because the distance the piston travels apart from the upper dead point is still small at that moment, the working medium has to flow not back to the cylinder, but outside the intake tract, which can cause considerable damage to the intake tract, but no work in the working space.

The first and second ways of fuel preparation disclosed in *Raab* are merely ways of preparation of the working medium before the fuel injection, using the well known thermo-dynamic cycle. According to *Raab*, the thermo-dynamic cycle, i.e. the courses of all four strokes, does not change; it is only after the completion of all four strokes when a part of the exhaust gas is let into the intake tract to be retaken later. The condition of the working medium changes in a single working space from which the working medium is not let out during the cycle; it is only after completion of all strokes of the cycle when a part of the

exhaust gas is let out and a part is used to preheat fuel for the next cycle. According to *Raab*, the remaining part of the exhaust gas released from the working space to the intake tract returns to the working space.

In both the first and second ways of fuel preparation of *Raab*, fuel is injected at an improper time, i.e. at the end of the exhaust stroke or at the beginning of the intake stroke, instead of being injected at the proper time, which is at the end of the compression stroke.

The Claimed Invention

The claimed invention, in contrast to *Raab*, recites a new thermo-dynamic cycle that injects the fuel at the appropriate and most efficient time.

The working medium of the claimed invention is transferred from the second-stroke chamber to the third-stroke chamber to the fourth-stroke chamber, and is heated when it goes through the third-stroke chamber. Heat is not provided in the chamber into which the working medium is taken or in which the working medium expands, but heat is instead provided in a separate space of a fixed volume, during a separate stroke. That leaves more time left for intaking the heat. If heat is generated by combustion, combustion is more calm and perfect.

The chamber of the third stroke allows the medium to flow through; the working medium enters the third-stroke chamber from one side and leaves it from the other side. The larger the volume of the third-stroke chamber, the longer the time the working medium stays in the third-stroke chamber allowing a longer time for heat intake.

For the internal combustion engine of the claimed invention to deliver work, the working medium is compressed and then heated to expand the working medium. In the case of conventional internal combustion engines, heat is fed all at once, thus the time for the heat intake is practically zero. To reduce the surge due to this sudden heat intake, so as to prevent explosion, conventional internal combustion engines have to use a part of the compression stage and also a part of the expansion stage for combustion.

By using the process and apparatus of the claimed invention, the working medium is taken in during one stroke, it is compressed during the second stroke and heated for any length of time in the third stroke to be expanded and exhausted later. No part of exhaust gas returns to any stoke.

The claimed invention is a new, five-stroke thermo-dynamic cycle. The individual strokes, i.e. the changes of the working medium condition, take place when the working medium is transferred from one working chamber to another one.

Moreover, the claimed invention has rotary pistons in the chambers of the first, second, fourth, and fifth strokes. When the working medium is expanded from the first-stroke chamber to the second-stroke chamber, pressure is overcome by the first rotary piston; the second piston acts at that moment as a motor. When the working medium is transferred from the second-stroke chamber through the third-stroke chamber to the fourth-stroke chamber, the rotary piston of the fourth stroke delivers work, while the second-stroke rotary piston consumes work. The pistons are double-action; one side of the piston delivers work, the other side consumes it. The same relations also apply to the fourth-stroke and fifth-stroke chambers. Due to the difference in the magnitudes of individual strokes, the total work is positive, and the five-stroke engine features better efficiency rather than the four-stroke engine.

Also, the claimed invention uses the entire intake stroke, the expansion stroke is larger than the intake one, and no hot gas under pressure leaves the engine, which is the case with conventional engines, but the overpressure of outgoing gas is zero. The energy, which is normally lost in the exhaust, is also used.

Accordingly, *Raab* fails to anticipate the claimed invention, because the five-stroke process or apparatus of the claimed invention is not identically found in *Raab*. Therefore, Applicants believe claims 13-21 are allowable over *Raab*.

C. The Rejection of Claims 2-3 and 9 under 35 U.S.C. § 103(a)

Claims 2, 3 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raab. As discussed above, new claims 13-21 are believed to be allowable over *Raab*. Moreover, one skilled in art would not have found it obvious to modify *Raab* to meet the claimed invention.

V. CONCLUSION

Consequently, in view of the foregoing discussion and new claims 13-21, it is respectfully submitted that this application is in condition for allowance. An early and favorable action is therefore respectfully requested.

Please charge any shortage of fees or credit any overpayment thereof to BLANK ROME LLP, Deposit Account No. 23-2185 (124166.0101). In the event that a petition for an extension of time is required to be submitted herewith and in the event that a separate petition does not accompany this report, Applicant hereby petitions under 37 C.F.R. §1.136(a) for an extension of time for as many months as are required to render this submission timely. Any fee due is authorized above.

Respectfully submitted,

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APPENDIX A

~~Process and apparatus for conversion of heat energy into mechanical energy~~**METHOD AND DEVICE FOR CONVERTING HEAT ENERGY INTO MECHANICAL ENERGY**

~~Description~~

Field of Invention:

The present invention ~~refers~~relates to ~~the~~a process of the conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium, primarily gas in number of steps, and simultaneously ~~refers~~relates to ~~the~~an apparatus for performing ~~this~~the process~~, too~~.

Background to the Invention:

There are known concepts of the conversion of heat energy into mechanical energy, where temperature and pressure is changed in the workspace with alternately changing volume. ~~During~~As the volume ~~decreasing~~decreases, temperature and pressure ~~increases~~increase both due to this volume change and primarily, in the last stage, due to the volume decreasing, or optionally, in the first stage ~~of~~due to the volume reincreasing, by the additional supply of heat energy either from the exterior, or from the heat generation (e.g. combustion) inside the workspace. ~~During~~As the volume ~~reincreasing~~reincreases, the pressure (originated from the previous workspace volume decreasing) ~~performs~~, after loss deduction, performs the work needed for consecutive volume decreasing. While the

pressure, originated from the additional heat energy supply, ~~performs,~~ after the loss deduction, ~~the resultant~~performs the resulting mechanical work. At the permanently closed work space concept, the work medium temperature (due to the additional heat energy supply) would be, at the end of the operating cycle, greater ~~then~~than the temperature at the beginning of the previous volume increasing. So that, during an exterior heat supply, the medium temperature would reach the temperature, where the heat is supplied from the exterior and the temperature difference and also volume of the supplied heat would be, without a view to the losses, zero. The heat supply, developed in the medium, would stop ~~for~~due to the lack of oxygen, at the permanently closed workspace. It is therefore necessary to open the workspace for the used medium exhaust and the fresh medium supply for a certain time, namely both at the beginning of the volume decreasing, or before it and at the end of the volume increasing, or after it. The power cycle of the pressure and temperature variations, during the volume increasing and decreasing, proceeds in two stages. If there are other two stages added to the previous ones (i.e. volume increasing for the used medium supply and volume decreasing for the used medium exhaust) then there is the four-cycle process of the conversion of heat energy into mechanical energy implemented. If the medium supply and exhaust take ~~places~~place at the beginning of the first stage, or respectively at the end of the second ~~one~~stage, then ~~there is~~ the two-cycle process is implemented. All of these processes take ~~places~~place according to the known state of art in one workspace, exceptionally divided into two parts.

Summary of the Invention:

~~Work~~According to the present invention, work medium is sucked ~~according~~ to the ~~invented~~ conversion of heat energy into mechanical energy by means of pressure and temperature change of the work medium into the first stage chamber simultaneously with the volume increasing of this stage~~, whereon~~ chamber, whereby it transfers into the second stage chamber during the first stage chamber volume decreasing, ~~whereon~~whereby it transfers (during the second stage chamber volume decreasing) through the third stage chamber, simultaneously with the fourth stage chamber heat supply and simultaneously with this fourth stage chamber volume increasing, ~~whereon~~whereby it transfers from the fourth stage chamber (during its stage chamber volume decreasing) into the fifth stage chamber, where it is ~~let~~permitted to ~~be expanded~~expand. The concept ~~is~~ according to the present invention is described by the transfer of work medium through the third stage chamber simultaneously with the second stage chamber decreasing, simultaneously with warming, into the fifth stage chamber, or can be described by cooling during the transfer of the medium through the first stage chamber into the second one. ~~Other attribute~~Another aspect of the present invention is that the work medium is transferred, simultaneously with its cooling, from the fifth stage chamber into the first stage chamber simultaneously with this first stage chamber volume increasing. The concept can be, according to the present invention, modified so that the work medium is transferred from the fifth stage chamber, simultaneously with its ~~volumen~~volume decreasing, into

the third stage chamber and is used for the warming process, or that the fifth stage chamber is joined with the first stage chamber and simultaneously with decreasing of the ~~volumen~~volume of this joined stage chamber is work medium (optionally with the simultaneous cooling) transferred directly into the second stage chamber, simultaneously with increasing ~~des volumens~~the volumes of this second stage chamber. The apparatus for a multistage chamber conversion of heat energy into mechanical energy by means of changing volume, pressure and temperature of the work medium has the third stage chamber in form of a workspace with an invariable volume, while the other ~~stages~~stage chambers are arranged as workspaces with variable volume (particularly as piston machines with the revolving piston) and are functionally, in a way of the work medium transfer, arranged one behind the other, partly before the third stage chamber and partly behind the third stage chamber. The apparatus for performing the present invention ~~concept~~ is ~~furthermore~~further adapted in a way, so that the largest volume of the first stage chamber is larger then the largest volume of the second stage chamber, while the largest volume of the fifth stage chamber is larger than the largest volume of the fourth stage chamber, while the ~~largets~~largest volume of the fifth stage chamber is larger than the largest volume of the first stage chamber or equal to the largest volume of the first stage chamber. The apparatus, according to the present invention, can be furthermore arranged, so that the fifth stage chamber concurrently forms the first one. According to another aspect of the ~~next~~present invention ~~character~~, the third stage chamber is created as a combustion chamber and/or

a heat exchanger. The present invention is furthermore expediently adapted so that the fifth stage chamber is equipped by the inlet valve. According to this aspect of the ~~last~~present invention ~~character~~, the cooler is inserted between the first stage chamber and the second stage chamber, and also between the fifth stage chamber and the first stage chamber and also between the joined stage chamber and the second stage chamber.

Brief Description of the Drawings:

The present invention is readily understood from the Drawings, in which:

~~The invention can be closely seen on the attached drawing. The basic invention concept can be seen on Picture 1. Picture~~Figure 1 shows an apparatus of the present invention; Figure 2 shows a version with the cooler between the first stage chamber and the second stage chamber and also between the fifth stage chamber and the first stage chamber in accordance with the present invention; and ~~Picture~~

Figure 3 shows a concept with the first stage chamber joined together with the fifth stage chamber and a concept with the cooler between the fifth stage chamber and the second stage chamber in accordance with the present invention.

Detailed Description:

Work medium is brought into the first stage chamber 1 during the first stage chamber volume increasing, ~~see~~

~~Picture~~as in Figure 1, ~~whereon~~whereby it is, during the first stage chamber 1 volume decreasing, it is transferred into the stage chamber 2, simultaneously with its volume increasing. It is then, during the second stage chamber 2 volume decreasing, transferred into the third stage chamber 3. While transferring through the third stage chamber 3, heat is supplied into work medium either from inside by fuel combustion, or from outside by the third stage chamber heating e.g. by exterior combustion. Work medium is transferred from the third stage chamber 3 into the fourth stage chamber 4, whose volume simultaneously increases, whereon it is, from the fourth stage chamber 4, concurrently with its volume decreasing, transferred into the fifth stage chamber 5. In this fifth stage chamber 5, the work medium is allowed to expand within its volume increasing. Work medium is after its expansion, concurrently with the fifth stage chamber 5 volume decreasing, either conducted outside, or inside back into the first stage chamber 1. When using air as a work medium and exterior combustion as a concept of the heat supply into the third stage chamber, it is convenient to use expanded, but hot, air for the inside combustion. The ~~invented concept~~present invention therefore presents five-cycle thermo dynamical cycle. ~~There~~These can be convenient~~;~~, in some cases, to avoid the fourth stage chamber 4 and to transfer work medium into the fifth stage chamber and allow it to expand in this stage chamber. It is convenient, when work medium is cooled inside the interstage cooler 6, during its transfer from the stage chamber 1 into the second stage chamber 2 (see Picture 2). In the closed cycle, where the work medium is transferred from the fifth stage chamber 5 back into

the first stage chamber 1, it is convenient to insert other interstage cooler 7 between the fifth and the first stage chamber. It is also convenient, in some cases, according to the other invention concept, to join the fifth and the first stage chamber into the joined stage chamber 51 and to transfer (during this joined stage chamber volume re-decreasing) work medium, expanded during the joined stage chamber 51 volume increasing, into the second stage chamber 2, simultaneously with this second stage chamber increasing, optionally through the joined interstage cooler 76. The basic five-stroke cycle is, in this case, adapted into the three-stoke cycles.

The apparatus, as described above, performing the conversion of heat energy into mechanical energy is according to the invention, arranged in a way, so that the third stage chamber 3 composes from, at least, one workspace with an invariable volume, while the other ~~stages~~stage chambers 1, 2, 4, 5, 51 are created as workspaces with the variable volumes. It is convenient to create all the ~~stages~~stage chambers, excluding the third one, as piston machines with the revolving piston. ~~In such concept where,~~Where the cusps edges join together during the piston revolution above each plane, the space volume may be enclosed by this area and the inclined inside cylinder plane, where the piston revolves in, decreases. ~~Hereat~~Here, the largest volume of the first stage chamber 1 is larger than the largest volume of the second stage chamber 2, and furthermore, the largest volume of the fifth stage chamber 5 is larger than the largest volume of the fourth stage chamber 4 and the largest volume of the stage chamber 5

is larger than the largest volume of the stage chamber 1. The largest volume of the joined stage chamber 51 is larger than the largest volume of the stage chamber 4 and also larger than the largest volume of the stage chamber 2. The third stage chamber 3 is created as a combustion chamber and/or as a heat exchanger. Work medium is firstly supplied (e.g. by sucking) into the increasing volume of the first stage chamber 1. After reaching maximum, the volume of this stage chamber begins to decrease and work medium is exhausted into the increasing volume of the second stage chamber 2. Because the largest volume of the second stage chamber is many times smaller than the largest volume of the first stage chamber 1, the state of work medium changes so that, after its shift from the first stage chamber 1 into the second stage chamber 2, this medium has higher pressure and also higher temperature. If the temperature increase is not desirable, it is possible to insert the interstage cooler 6 between both of the ~~stages~~stage chambers according to the ~~Picture~~Figure 2. ~~During~~When the volume ~~re-decreasing of~~again decreases in the second stage chamber 2, work medium is transferred from it through the third stage chamber 3 into the fourth stage chamber 4, while increasing its volume. Heat is supplied into work medium in the third stage chamber 3 either by inside combustion, where the stage chamber is made as a heat exchanger, or by inside combustion in a way of the combustion in the turbine's combustion chambers, but under considerably higher pressure. Because the largest volume of the fourth stage chamber 4 is generally equal to the largest volume of the second stage chamber 2, work medium has in the fourth stage chamber 4, after warming in the third stage chamber, in the final state,

higher pressure and also higher temperature contrary to the initial state in the second stage chamber 2. Work medium expands from decreasing volume of the fourth stage chamber 4 into increasing volume of the fifth stage chamber 5, where it performs work. It is also possible to adapt this apparatus according to the present invention, so that the largest volume of the fourth stage chamber 4 is larger than the largest volume of the second stage chamber 2, so that the partial isobaric to isothermal expansion between both of the ~~stages~~stage chambers will occur and this adaptation will reach Carnot's cycle concept. In an extreme case, it is possible to completely avoid the fourth stage chamber and to let work medium expand from the second stage chamber 2, during warming in the third stage chamber 3, into the fifth stage chamber 5. The third stage chamber has a nonzero volume so that, if there is no heat supplied, the partial expansion occurs at the beginning of the work medium transfer and after transferring through the third stage chamber into the fourth stage chamber, work medium has lower pressure and also lower temperature then in the second stage chamber. However, due to this lower pressure, the fourth stage chamber takes proportionally lower weighted quantity of work medium than it is supplied into the third stage chamber from the second stage chamber and the residual quantity generates, or optionally increases, the residual pressure in the third stage chamber. According to the size of the third stage chamber, in this manner also without heat supply, the pressure in the third stage chamber very quickly rises, so that expansion, within the work medium transfer from the second stage chamber into the third stage chamber, does not occur and it is

possible to supply heat under the pressure given by compressed work medium from the first stage chamber into the second stage chamber. It is therefore possible to dimension the third stage chamber both as a combustion chamber with a small external area, so that needles heat leak does not occur, and as a heat exchanger with a large area, so that it is possible to supply the largest heat quantity possible. In order to supply the largest possible heat quantity into the third stage chamber and to decrease the work expended during the compressional stage chamber of the cycle, it is, if possible, needed to decrease temperature during the transfer from the first stage chamber into the second one. It is, according to the present invention, enabled by inserting the interstage cooler 6 between the first stage chamber 1 and the second stage chamber 2. At the enclosed cycle, where work medium is transferred from the fifth stage chamber 5 back into the first stage chamber 1, it is appropriate to insert an innerstage cooler 7 between these two ~~stages~~stage chambers. At the configuration according to the invention, it is possible to choose, independently upon the compression ratio, magnitude of the expansion ratio, so that it is possible to expand compressed to the pressure of the surrounding environment and heated work medium, whereby a good cycle efficiency is reached. At the given expansion ratio, the pressure at the end of the expansion is given by magnitude of the pressure at its beginning and this pressure, at the end of the expansion, can therefore, at the smaller heat supply, drop under the surrounding environment pressure. If this phenomenon is not desirable, it is possible to ~~use~~incorporate other ~~invention character~~inventive aspects i.e. additional

work medium inlet through the inlet valve 8 at the end of the expansion. The power cycle, realized according to the present invention ~~concept~~ and apparatus, is therefore five-stroke cycles. At certain expansion ratio magnitude in the fifth stage chamber 5 (i.e. the ratio between the largest volumes of the fifth and fourth ~~stages~~stage chambers), not only the pressure at the end of the expansion, but also the temperature drops to the value of the surrounding environment. It is therefore possible at the enclosed cycle and at the outside work medium warming, which take place in the third stage chamber 3, according to the other invention character, to join the fifth stage chamber 5 with the first stage chamber 1 according to ~~the Picture~~Figure 3 and to transfer work medium after expansion in the convenient way from the joined stage chamber 51 through the interstage cooler 76 into the second stage chamber 2 concurrently with its compression. In this case, it is also desirable to equip the joined stage chamber 51 by the inlet valve 8. It is therefore possible, in some cases, within the invention, to adapt the five-stroke cycle to the three-stroke cycle.

The present invention is, both according to the design examples ~~and also according to the other designs resulting from the patent requirements and comparing~~mentioned previously and in comparison to the other known heat engines, more convenient especially by its possibility to allow higher working pressure and temperature then turbine engines, longer warming of the compressed work medium and lower pressure and temperature at the end of the expansion then so far know piston engines. Higher cycle efficiency, lower emissions

of the carbon and nitrogen oxides, lower noise in the case of work medium warming by external or internal combustion is the outcome of the present invention. It is also possible to use ~~this~~the present invention for the conversion of solar energy into mechanical energy.